Dickey River watershed –

The Dickey River watershed is the last major contributing area to the Quillayute River before it outflows into the Pacific Ocean. As illustrated in Figure 23 below, the Ozette River watershed is located to the west of the Dickey River watershed, while the Soleduck River is located to the east. Dickey River is fed by two main tributaries, the East Fork and West Fork Dickey Rivers. The direction of flow is in the southwestern direction before outflowing into the Quillayute River at RM 1.2.

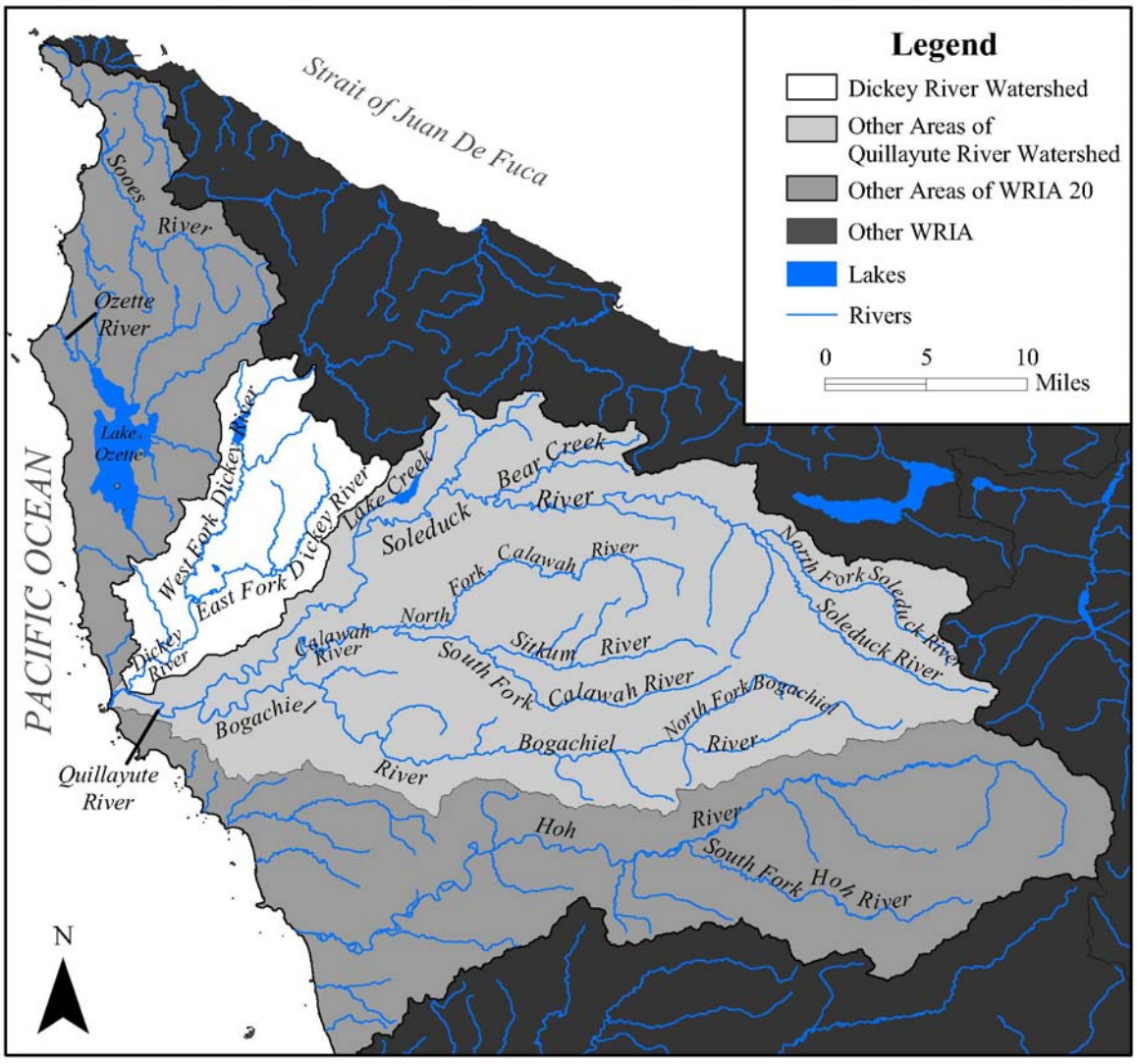

Figure 23. Location of Dickey River watershed within WRIA 20

The Dickey River watershed measures over 107 square-miles in area, of which the majority is private owned. The remaining areas are administered either by the

State of Washington or fall within the Olympic National Park, as summarized in Table 44 and illustrated in Figure 24 below. The small portion of land within the Olympic National Park is located at the mouth of the Dickey River watershed.

Table 44. Land Administration of the Dickey River watershed.

Land Administration	Area (sq. mi.)	Percent of Total Area
Olympic National Park	0.5	0.5
State of Washington	30.9	28.8
Privately owned	75.8	70.7
Total Area	107.2	100

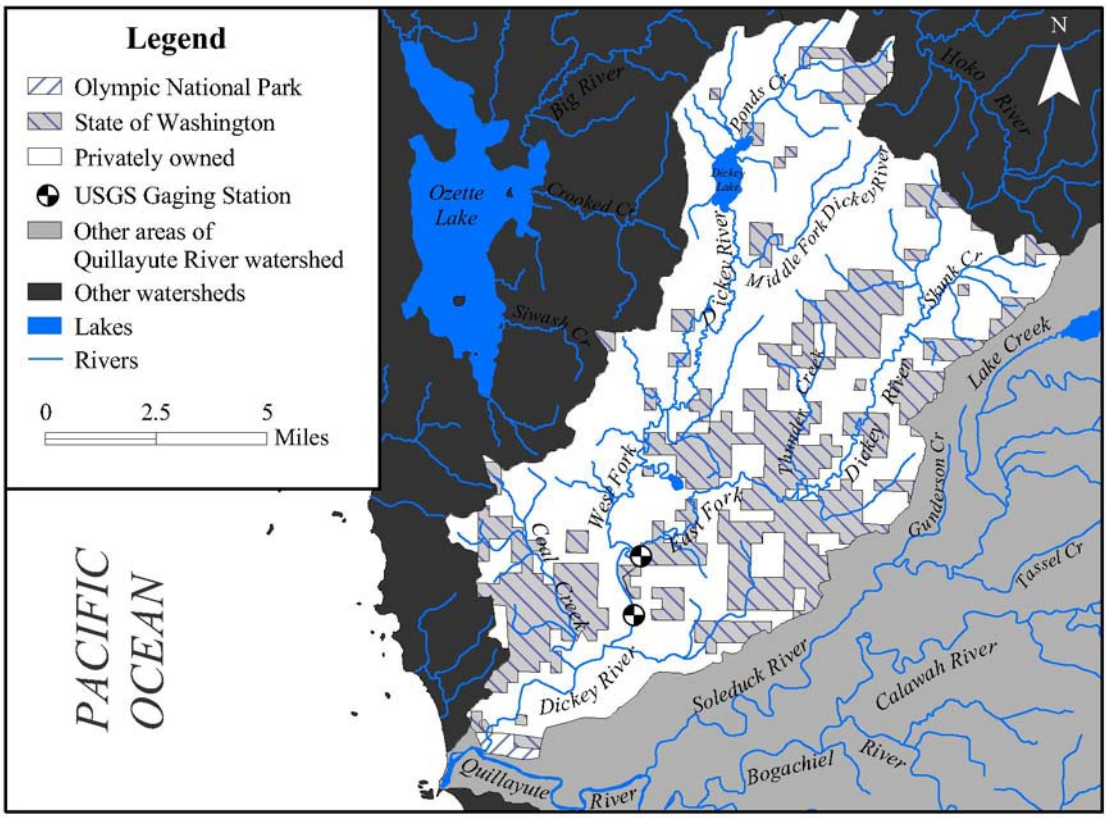

Figure 24. Land Administration of the Dickey River watershed.

Precipitation in the Dickey River watershed decreases from east to west, averaging over 120 inches annually at the headwaters down to less than 77 inches near the outlet. Also, elevation ranges from below 20 feet above sea level at the outlet to over 1950 at the headwaters. Since the elevation of this watershed are lower than most seen in the other Quillayute River watersheds, the watershed characteristics are dominated by upland and lowland subwatershed. The distribution of watershed characteristics is illustrated in Figure 25 and

summarized in Table 45. Unlike other Quillayute subwatershed, the coastal lowland subwatershed of the Dickey River was found to contribute directly to streamflow and is indicated to be "effective."

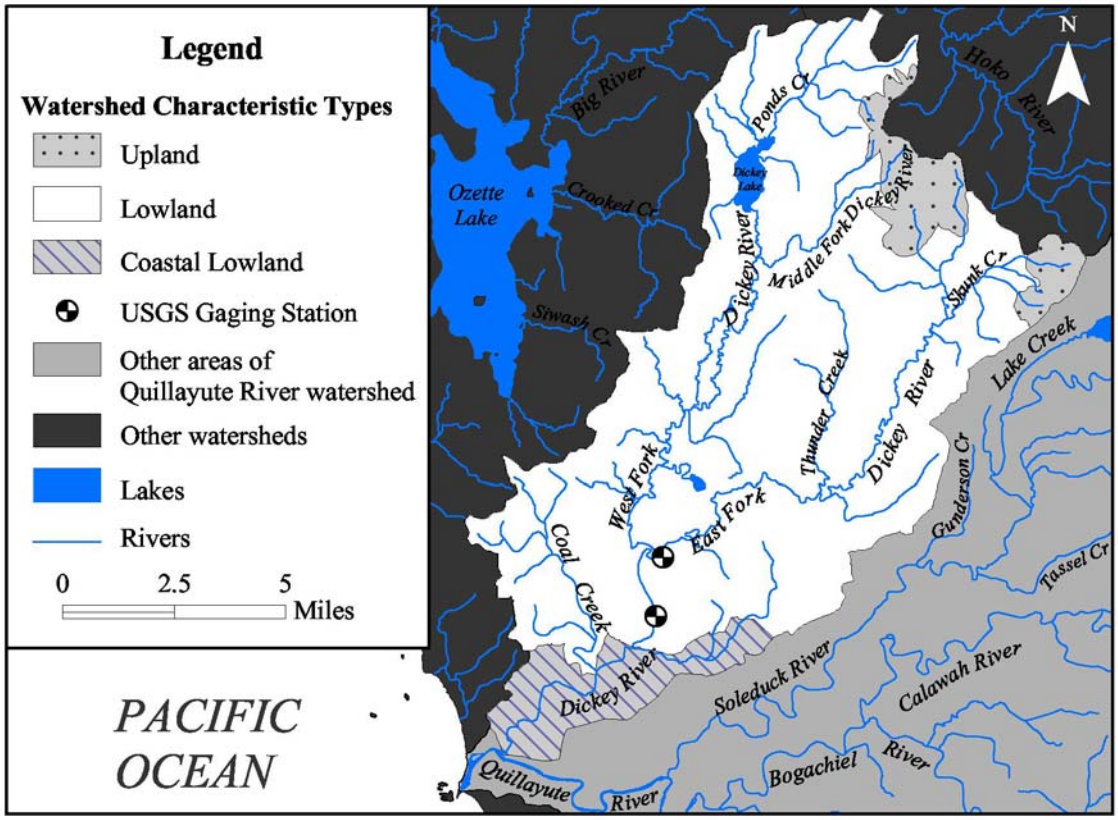

Figure 25. Watershed Characteristics within the Dickey River watershed.

Table 45. Watershed Characteristics within the Dickey River watershed.

Watershed Characteristics	Area (sq. mi.)	Percent of Total Area
Upland	6.6	6.2
Lowland	92.3	86.1
Coastal Lowland	8.3	7.7
Total Area	107.2	100

Streamflow Evaluations of the Dickey River

Streamflow in the Dickey River watershed was estimated at the locations indicated in Figure 26. Streamflow evaluation sites were either gaged by the USGS or are illustrated as ungaged. Streamflow for each gage location was first extended beyond the gaged period of record to create an complete, extended, synthetic period of record between October 1961 and September 1999. The watershed characteristics of the area above each gage enabled the estimation of streamflow at ungaged locations by use of the watershed characteristics method.

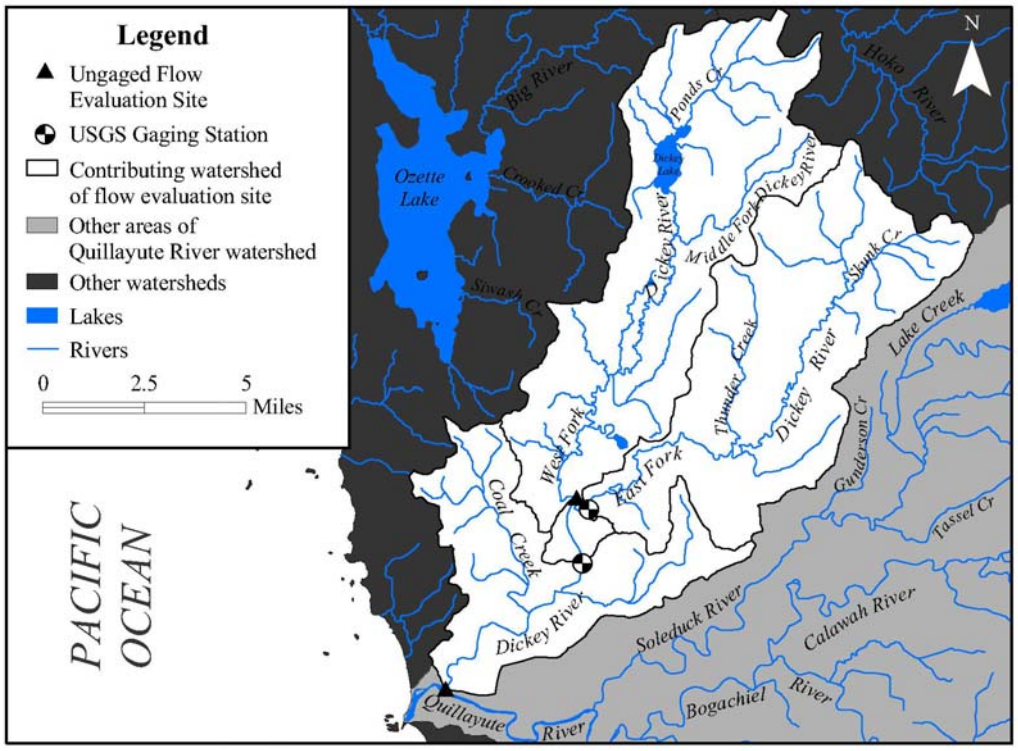

Figure 26. Flow evaluation sites within the Dickey River watershed.

Streamflow of the Dickey River watershed was measured by the USGS at two gage locations. These gages are:

- USGS Station Number 12043080 East Fork Dickey River near La Push, WA
- USGS Station Number 12043100 Dickey River near La Push, WA

Extended periods of record for these gages were reconstructed using regression techniques in two separate efforts due to a change in personnel at Reclamation. A separate explanation for each final extended synthetic record is needed to clarify how the final data was developed and is documented in detail in the following sections, under their respective flow evaluation descriptions.

Streamflow was estimated at the ungaged sites by the watershed characteristics method. As such, watershed characteristic information was needed for each contributing watershed. A summary of the areas within each watershed characteristic type designated by contributing watershed, as described in Table 46. Also, the average annual precipitation values used to weight streamflow in the watershed characteristics method are summarized in Table 47.

The variability of streamflow at each of these locations is described in detail below. The provided graphs illustrate the expected variation of naturally occurring streamflow for each accumulated watershed area. The range in variation is illustrated in approximate average monthly flow in cubic feet per second (cfs), and these values are summarized in the corresponding table for each evaluation site. These values are estimated from how frequent a monthly total flow occurred in the period between October 1961 and September 1999.

Table 46. Watershed characteristics within each portion of the Dickey River watershed.

Watershed Characteristic Types	East Fork Dickey River at gage # 12043080 or at Outlet Area (sq. mi.)	West Fork Dickey River at Outlet Area (sq. mi.)	Dickey River at gage # 12043100 – Dickey River nr La Push Area (sq. mi.)	Dickey River at Outlet Area (sq. mi.)
Upland	4.09	2.54	-	-
Lowland	35.5	40.9	1.64	14.2
Coastal Lowland	-	-	-	8.30
Entire area	39.6	43.4	1.64	22.5

Table 47. Average annual precipitation of each portion within the Dickey River watershed.

Watershed Characteristic Types	East Fork Dickey River at gage # 12043080 or at Outlet Ave Ann Precip (in.)	West Fork Dickey River at Outlet Ave Ann Precip (in.)	Dickey River at gage # 12043100 – Dickey River nr La Push Ave Ann Precip (in.)	Dickey River at Outlet Ave Ann Precip (in.)
Upland	117.3	114.6	-	-
Lowland	102.3	96.8	85.5	84.0
Coastal Lowland	-	-	-	83.2
Entire area	103.8	97.8	85.5	83.7

East Fork Dickey River at the Outlet (at USGS gage 12043080) –

Streamflow measurements were collected by the USGS in the East Fork Dickey River at a gage location just upstream of the confluence with the West Fork Dickey River, where the Mina Smith Rd crosses the East Fork Dickey River. The USGS measured streamflow at this location for the two months of August and September 1962 and continuously between April 1963 and September 1968. As mentioned previously, an extended period of record for this gage was reconstructed using regression techniques in two separate efforts due to a change in personnel at Reclamation. The initial reconstruction effort created a complete synthetic period of record for this gage between October 1961 and September 1998. This reconstruction was undertaken after an extended synthetic period of record was generated for the Dickey River main stem gage. The original East Fork extended record was estimated directly from the original synthetic record for the Dickey River gage. The Dickey River gaged record was extended using regressions developed against the extended record of USGS Gage 12043300, Hoko River near Sekiu. Both the extension of the Hoko River gage and the Dickey River gage were completed on a monthly basis (an equation was developed for each month to accurately reflect seasonal variability). As mentioned previously, the Hoko River gage was extended against total monthly precipitation measured at gages in Sappho, Clallam Bay, Forks, and Neah Bay.

When new personnel was assigned to this project, several values in the original extended record for the East Fork Dickey River gage were updated to more accurately account for baseflow conditions in the late summer months of August and September, as well as to extend the record to include water year 1999 (October 1998 to September 1999). These updated months were estimated mainly from regression equations developed against gaged monthly totals from the Hoko River streamflow gage, but 4 monthly total streamflow values were updated based the Hoko River synthetic record. Of course, the extended synthetic Hoko River period of record was updated also as a result of the change in personnel. This new Hoko River record was redeveloped based on entirely streamflow data and did not use any local precipitation gages. These remaining 4 months were estimated using regression equations against this updated synthetic record for the Hoko River gage, which originated through regressions between the Hoko River gage and the streamflow gages on the Calawah River and the Hoh River at Highway 101.

As a result of this secondary effort, total monthly streamflow estimates were generated for 118 months or 26 percent of the entire period of record. These later additions are reflected in the first 4 rows of Table 48 below, which indicates the source of monthly total streamflow data estimated for the East Fork Dickey River and the percent of the total synthetic record that was estimated from each source.

Table 48. Methods used to develop final synthetic period of record for the East Fork Dickey River (at USGS gage #12043080).

Source/Method	Number of Months	Percent of Period of Record
USGS gaged streamflow on East Fork Dickey River	68	14.9%
Estimated using regression equations against Hoko River gage	46	10.1%
Estimated using regression equations against Hoko River estimates derived from Calawah River gage	2	0.4%
Estimated using regression equations against Hoko River estimates derived from Hoh River at Highway 101 gage	2	0.4%
Estimated using regression equations against Dickey River gage	109	23.9%
Estimated using regression equations against Dickey River estimates derived from Hoko River gage	84	18.4%
Estimated using regression equations against Dickey River estimates derived from Neah Bay Precipitation gage	85	18.6%
Estimated using regression equations against Dickey River estimates derived from Sappho Precipitation gage	50	11.0%
Estimated using regression equations against Dickey River estimates derived from Neah Bay Precipitation estimates	8	1.8%
Estimated using regression equations against Dickey River estimates derived from Sappho Precipitation estimates	2	0.4%
Total number of months	456	100%

The extended synthetic period of record developed for the East Fork Dickey River gage location was considered equal to the streamflow at the outlet, since the East Fork Dickey River only continues another 1100 feet before it joins the West Fork Dickey River to mark the beginning of the mains stem Dickey River. As such, the extended record was used to develop the illustration of streamflow variation in the East Fork Dickey River at the outlet. Streamflow in the East Fork Dickey River exhibits the greatest variation due to the winter seasonal precipitation maxima. The specific months with the greatest variation are from November to January. Streamflow recedes into baseflow conditions during the summer months of July and August, and baseflow conditions extend typically into September.

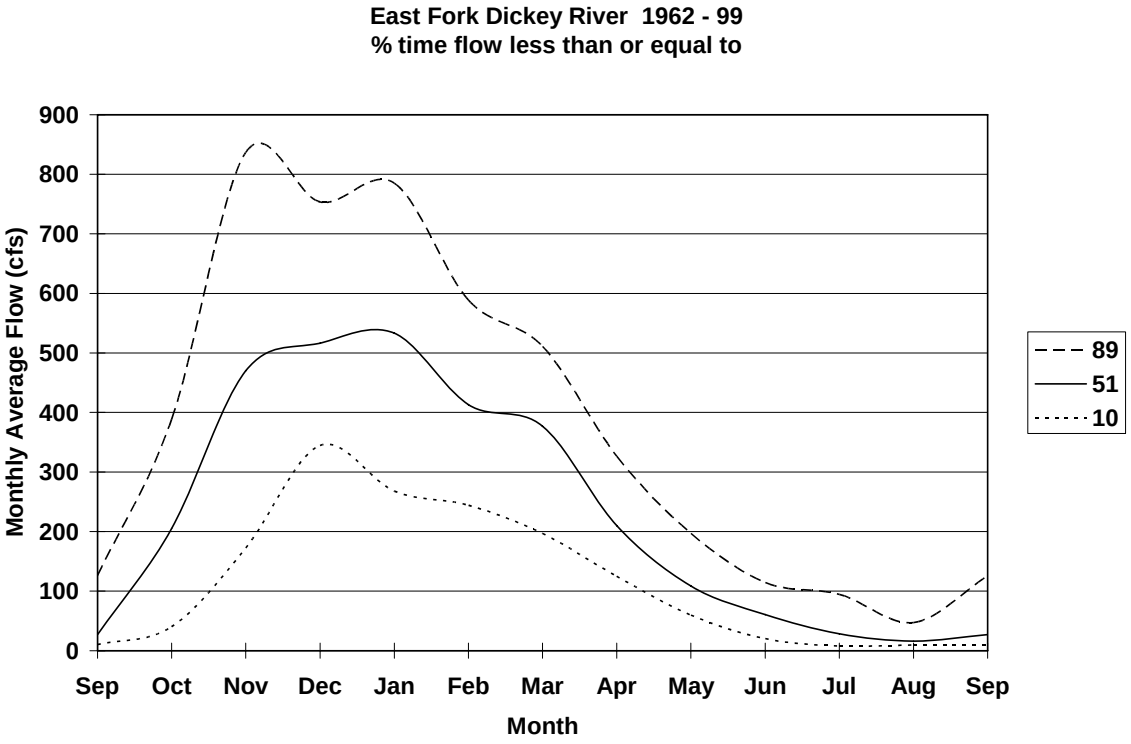

Table 49. The percent of time that average monthly streamflow (cfs) at the outlet of the East Fork Dickey River is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	389	836	753	785	589	511	326	197	115	95	47	126
51	205	470	516	533	413	377	210	109	61	28	16	27
10	40	172	344	268	244	197	125	60	20	8	9	10

West Fork Dickey River at the Outlet –

Streamflow in the West fork Dickey River was estimated using the watershed characteristics method. The West Fork Dickey River was estimated by the WCM subtracting the extended synthetic record for the East Fork Dickey River gage from the extended synthetic record for the Dickey River near La Push gage. Some additional flow was also subtracted from this resultant flow, to account for the additional flow that is generated by the contributing area between the Dickey River gage location and the confluence of the East Fork and West Forks. Several miscellaneous streamflow measurements were also collected by the USGS at the mouth of the West Fork Dickey River watershed. These 8 measurements were collected in the summer months between July 1962 and August 1966, which enabled calibration of monthly baseflow estimates. The streamflow in the West Fork Dickey River is very similar to that exhibited by the East Fork Dickey River, but are slightly greater due to the larger contributing area of the West Fork Dickey River watershed. The months of greatest variation are between November and January each year, and baseflow conditions occur in the late summer months of August and September.

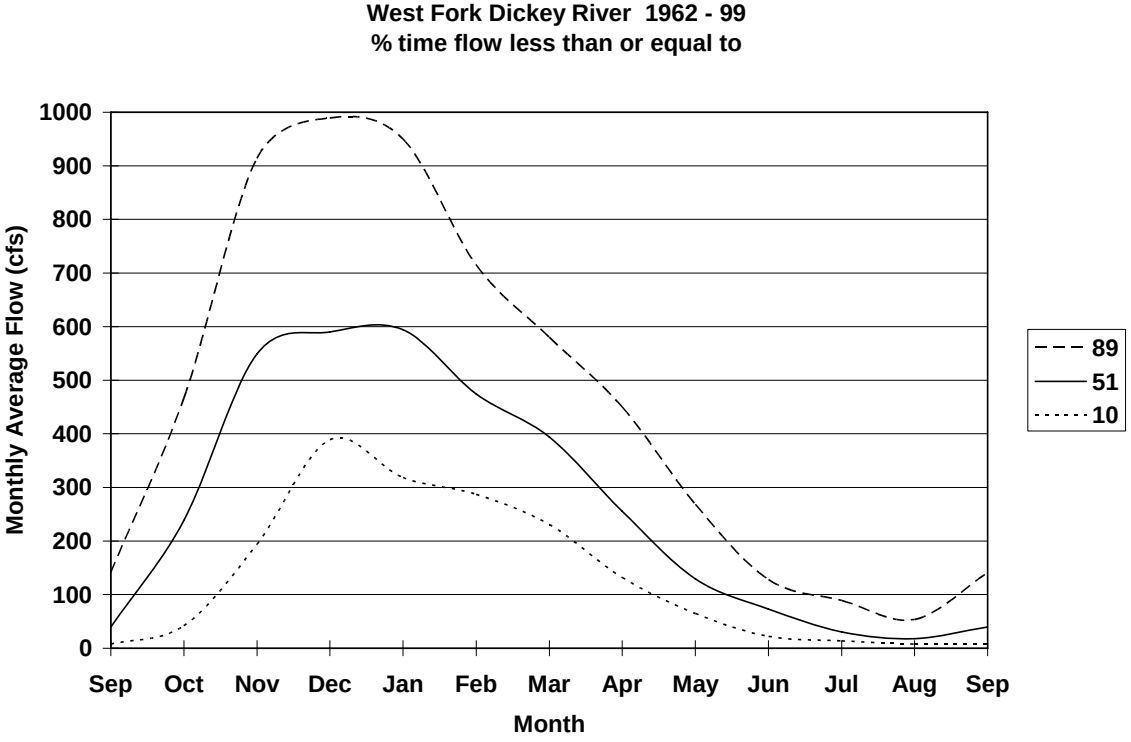

Table 50. The percent of time that average monthly streamflow (cfs) at the outlet of the West Fork Dickey River is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	466	914	989	950	715	580	450	268	128	89	54	141
51	239	549	590	594	474	394	255	129	73	30	18	40
10	42	194	389	318	287	231	132	65	22	14	8	8

Dickey River near La Push (at USGS gage 12043100) –

Streamflow measurements were collected by the USGS on the main stem of the Dickey River at RM 6.0. This gage was in operation continuously between September 1962 and October 1973, as well as continuously between October 1976 and September 1980. As discussed previously, the Dickey River gaged record was initially extended using regression equations developed against an extended synthetic record developed for USGS Gage 12043300, Hoko River near Sekiu. When new personnel was assigned to this project, the extended synthetic record for this gage was redeveloped entirely based solely on streamflow data. These estimates were developed using regression equations that were developed either for individual months, if sufficient coincidental data existed, or by including all months together in one dataset to generate only one relationship of monthly total streamflow between the gages. Although 403 months or 88 percent of the entire period of record was developed from other gaged values, the remaining 53 months had to be estimated from the extended synthetic period of record for the Hoko River near Sekiu gage (USGS gage 12043300). Of course, the extended synthetic Hoko River period of record was updated also as a result of the change in personnel. This new Hoko River record was also redeveloped based on entirely streamflow data and did not use any local precipitation gages. These remaining 53 months needed to complete the extended period of record for the Dickey River gaged were estimated using regression equations against this updated synthetic record for the Hoko River gage. These 53 months are reflected in the last 4 rows of Table 51, which indicates the source of monthly total streamflow data estimated for the Dickey River near La Push and the percent of the total synthetic record that was estimated from each source.

Table 51. Methods used to develop final synthetic period of record for the Dickey River near La Push (at USGS gage #12043100).

Source/Method	Number of Months	Percent of Period of Record
USGS gaged streamflow	181	39.7%
Estimated using regression equations against Hoko River gage	128	28.1%
Estimated using regression equations against Hoh River at Highway 101 gage	54	11.8%
Estimated using regression equations against Calawah River gage	32	7.0%
Estimated using regression equations against Bogachiel River gage	5	1.1%
Estimated using regression equations against Soleduck River near Fairholm gage	3	0.7%

Estimated using regression equations against Hoko River estimates derived from Calawah River gage	24	5.3%
Estimated using regression equations against Hoko River estimates derived from Sooes River gage	16	3.5%
Estimated using regression equations against Hoko River estimates derived from Hoh River at Highway 101 gage	10	2.2%
Estimated using regression equations against Hoko River estimates derived from Bogachiel River gage	3	0.7%
Total number of months	456	100%

Streamflow variation in the Dickey River near La Push is illustrated below in the percent of time an average monthly streamflow (in cfs) occurred between October 1961 and September 1999 (water years 1962 – 1999). The months with the greatest variation in streamflow occur during the winter months of November and January when winter precipitation is greatest. Baseflow conditions occur in the late summer months of August and September.

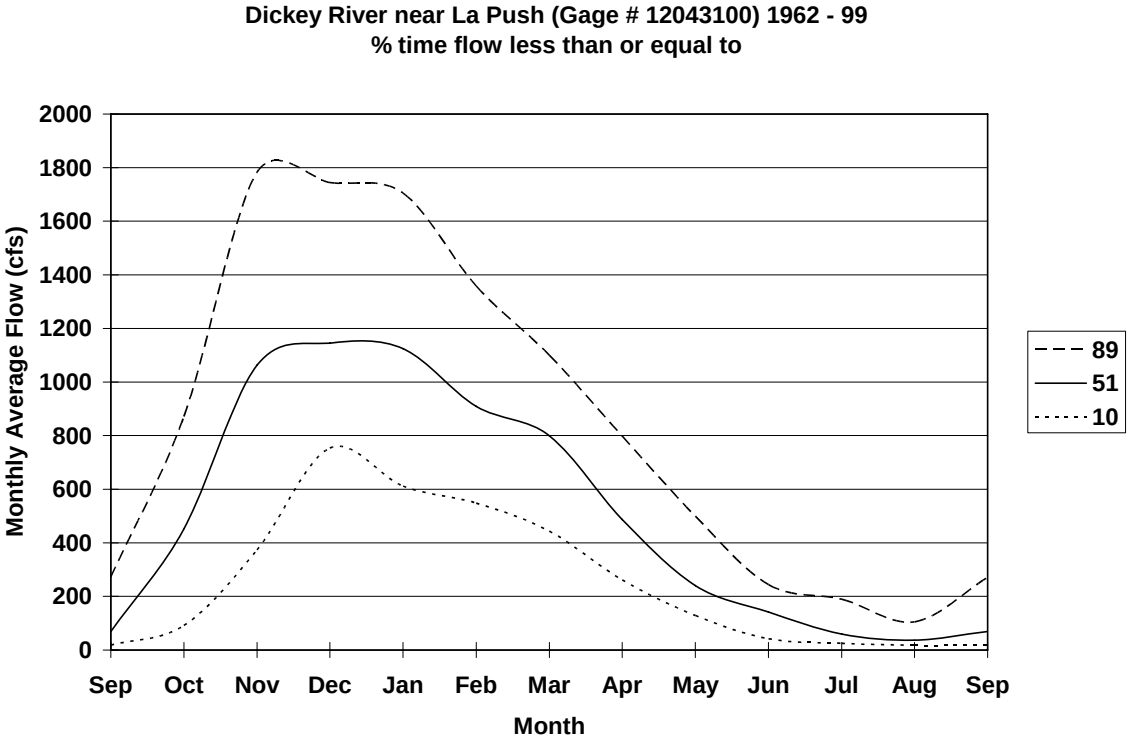

Table 52. The percent of time that average monthly streamflow (cfs) in the Dickey River near La Push is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	871	1782	1744	1704	1358	1100	798	499	244	189	105	271
51	452	1063	1145	1124	909	799	487	240	142	59	37	69
10	92	373	754	611	548	443	261	129	42	25	18	18

Dickey River at the Outlet –

The Dickey River is the last tributary to the Quillayute River before the outlet into the ocean, joining the Quillayute River at RM 1.25. Streamflow at the outlet of the Dickey River watershed was estimated by the WCM against USGS gage 120431000, Dickey River near La Push. Although the lower areas of the watershed exhibit coastal lowland characteristics, these areas were found to be effective by examining miscellaneous streamflow measurements collected during low flow conditions of September 2002. These measurements exhibited approximately a 3 cfs increase in streamflow between USGS gage 12043100, Dickey River near La Push and at RM 0.15 on the Dickey River. This estimated streamflow record can be found in Appendix 3. The resultant period of record was used to illustrate the variation in streamflow of the Dickey River at the outlet. The months of greatest variation are clearly between November and January. Baseflow conditions are similar to those found upstream, which extend between August and September.

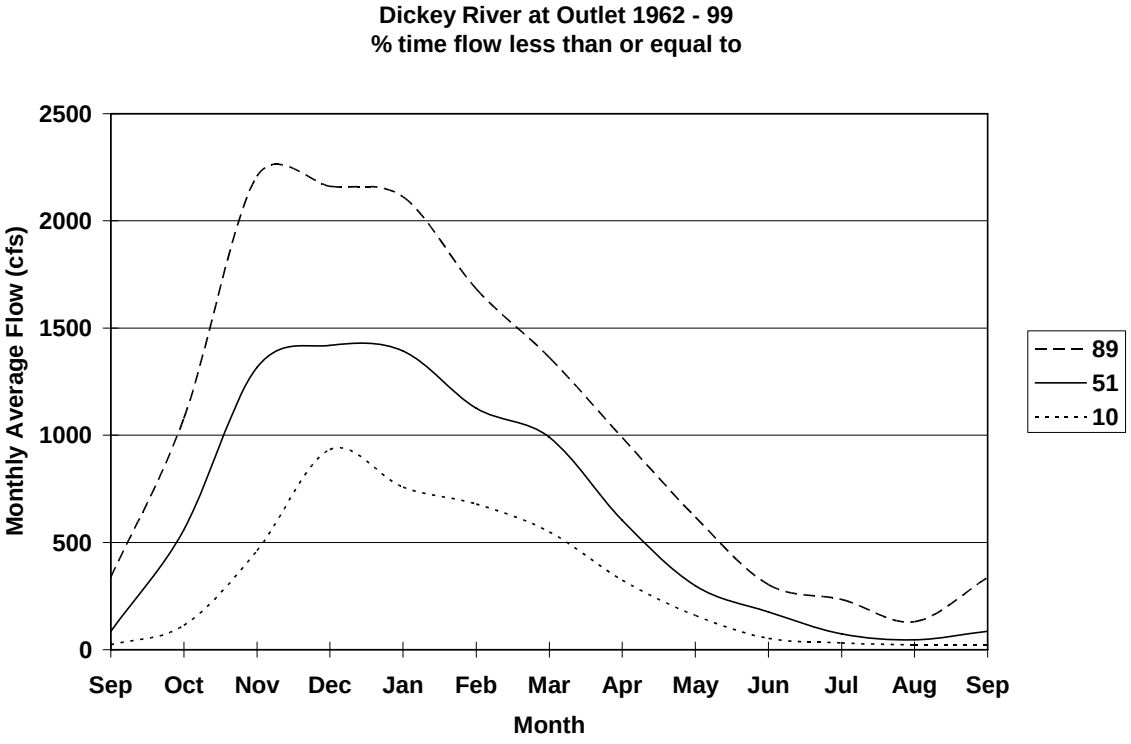

Table 53. The percent of time that average monthly streamflow (cfs) at the outlet of the Dickey River is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	1079	2208	2161	2112	1683	1363	989	619	302	234	131	336
51	560	1317	1419	1393	1126	990	604	298	176	74	46	85
10	114	462	934	757	679	549	324	159	52	31	22	22